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Kinetic Analysis of the Photocatalytic Degradation of Ethylene over TiO_2 Thin Films in a Batch Reactor

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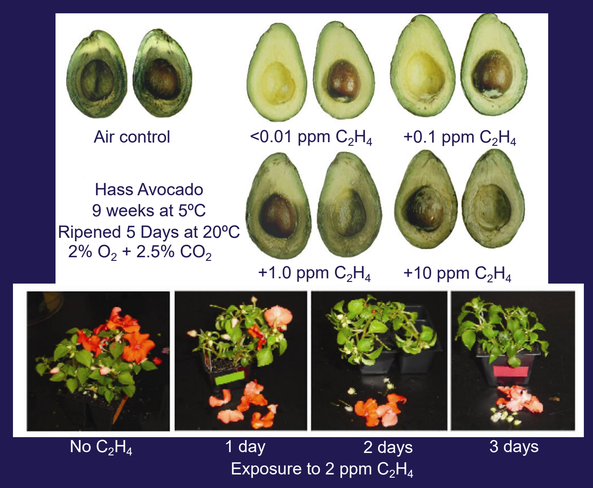
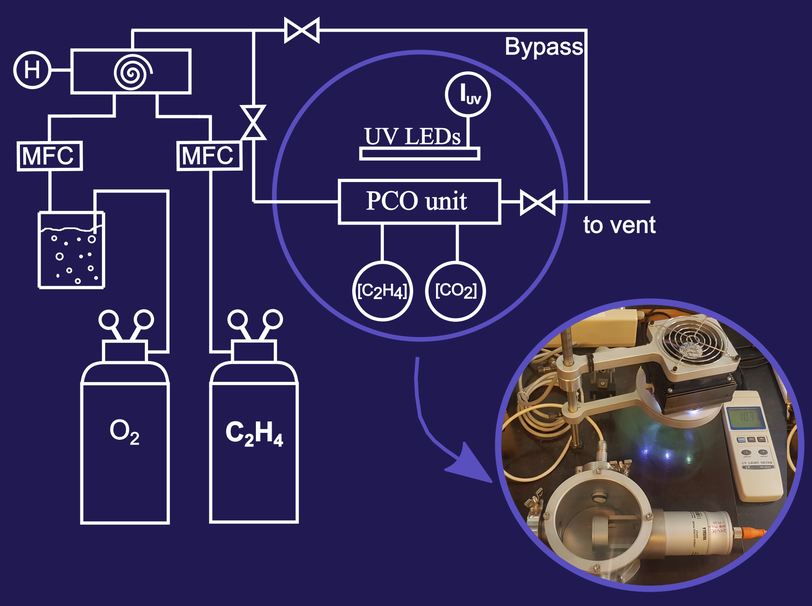
Introduction

- In the context of scarce resources, food waste needs to be addressed
- Ethylene (C_2H_4) - one of the main contributors to fresh produce spoilage in the postharvest industry
- Its removal has the potential of prolonging the shelf life of fresh produce
- Removal by photocatalytic oxidation over immobilized TiO_2 thin films
- Reaction is kinetically studied in a batch reactor, for subsequent modeling purposes
- Employed reaction models: first-order and Langmuir-Hinshelwood (LH) kinetics.

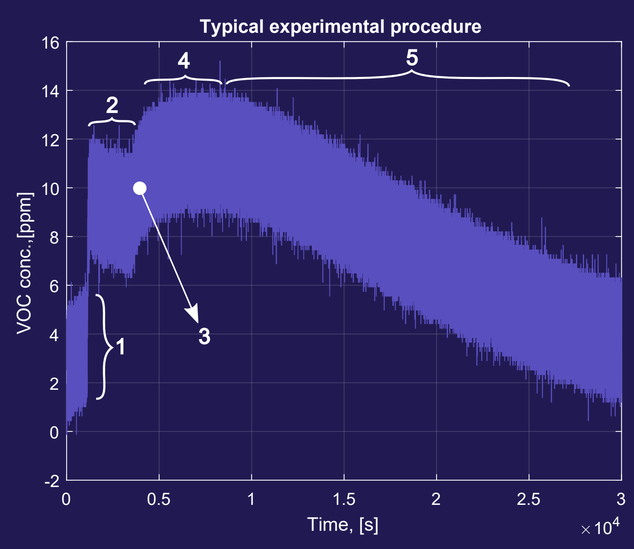


Experimental setup



Method

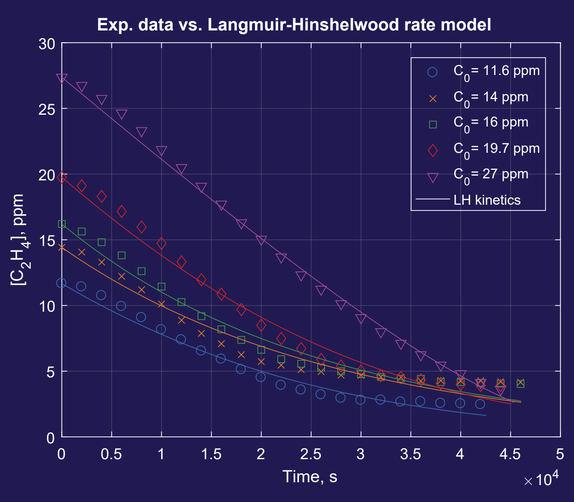
- Proposed 5-step experimental methodology

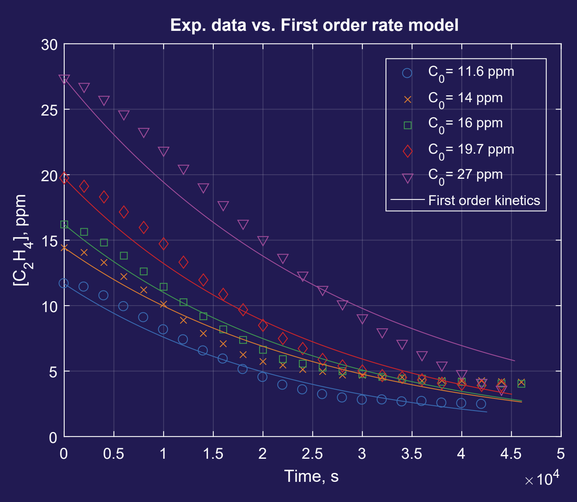


	C_{in} [ppm]	I_{UV} [W/m2]	q_{in} [cm³/min]	RH [%]
Effect of C_{in}	11,6 - 27	60	310 - 510	80
Effect of I_{UV}	10	3.9 – 5.1	510	

1. Warm-up
2. Stabilization
3. UV light ON
4. Desorption
5. Degradation

Results and Conclusions



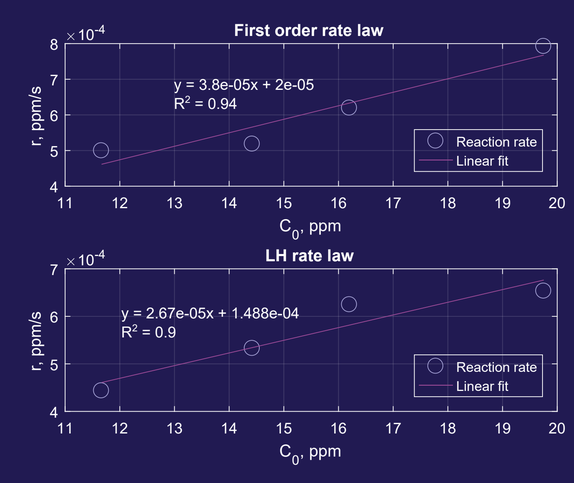


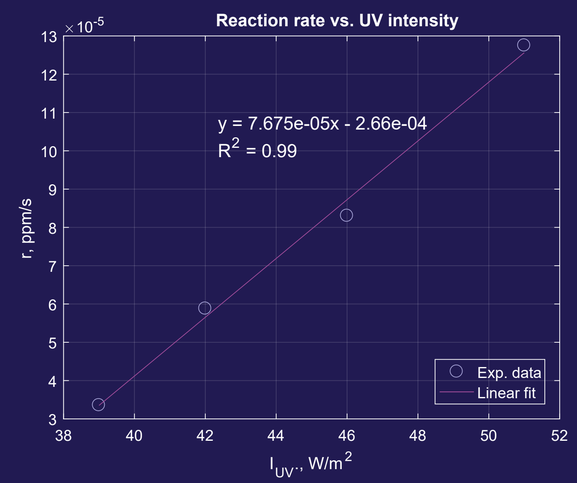
- Both the first order reaction model and the LH model represent the photodegradation of C_2H_4 over TiO_2 thin films satisfactorily

$$-r = \frac{dC}{dt} = \frac{k_r K_{abs} C}{1 + K_{abs} C} \qquad -r = \frac{dC}{dt} = k_{app} C$$

- Modeling with LH kinetics requires the use of the Lambert W-function, which is computationally heavy

$$z = f^{-1}(ze^z) = W(ze^z)$$





- Low pollutant molar concentrations → $K_{abs}C << 1$ → first-order kinetics
  → disadvantage: k_r and K_{abs} are treated as one, thus determining separate values becomes complicated
- Determined constants and prediction models = intrinsic
- r vs. C_{in}, r vs. I_{UV} } Linear dependence

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